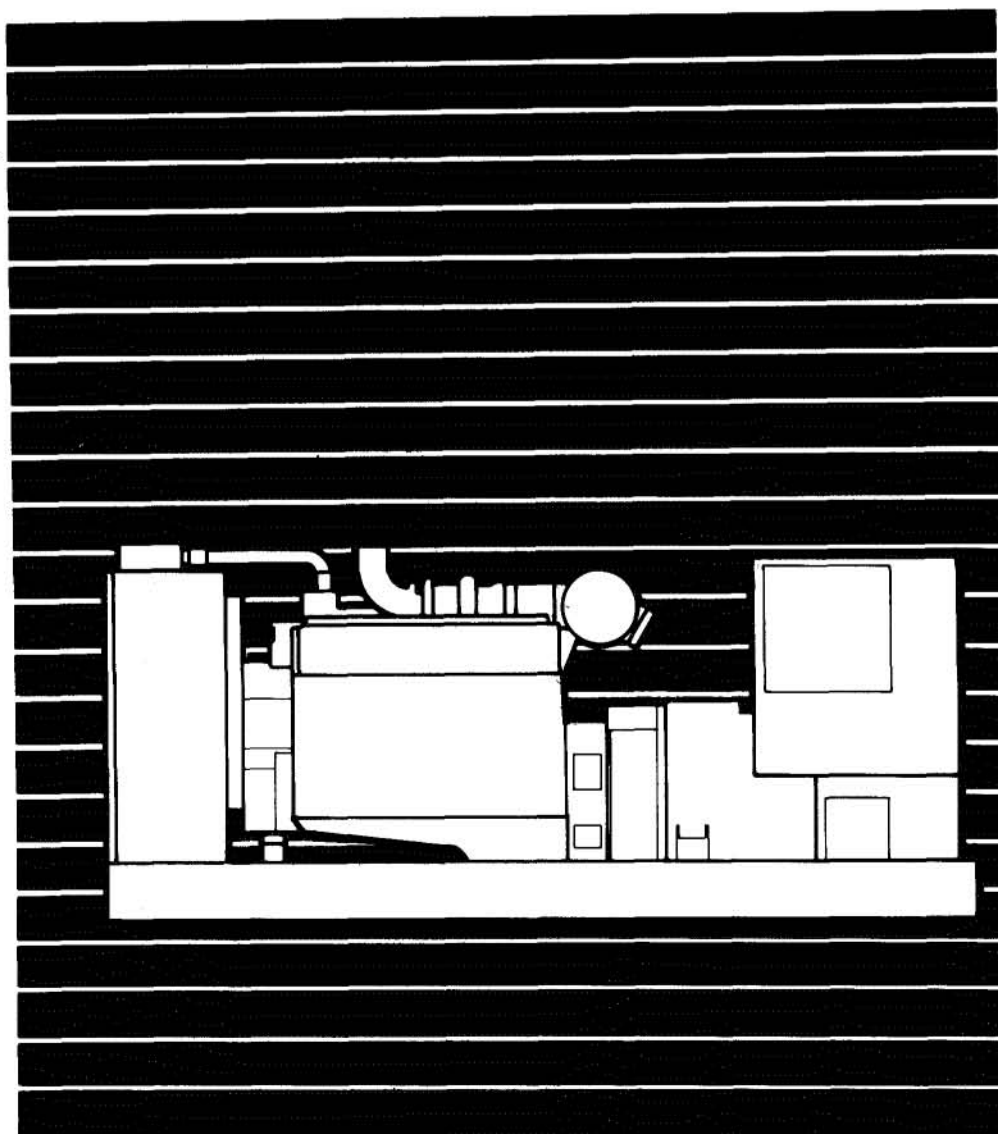




Operator's Manual

DGAB
DGAC
DGAD
DGAE
GENERATOR SETS

FILE COPY
LITERATURE SECTION
RETURN TO FILE
TECH. PUB. DEPT.



Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

▲ DANGER *This symbol warns of immediate hazards which will result in severe personal injury or death.*

▲ WARNING *This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.*

▲ CAUTION *This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.*

FUEL AND FUMES ARE FLAMMABLE. Fire and explosion can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.

- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

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Section 1. Introduction

ABOUT THIS MANUAL

This manual provides information for operating and maintaining the generator set. Study this manual carefully and observe all warnings and cautions. Using the generator set properly and following a regular maintenance schedule will contribute to longer unit life, better performance, and safer operation.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearest dealer or distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

If unable to locate a dealer or distributor, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS-ELECTRIC
ENGINES-GASOLINE OR DIESEL, OR
RECREATIONAL VEHICLES-EQUIPMENT,
PARTS AND SERVICE.

For the name of your local Cummins/Onan or Onan only distributor in the United States or Canada, call 1-800-888-ONAN (This automated service utilizes touch-tone phones only). By entering your area code and the first three digits of your local telephone number, you will receive the name and telephone number of the distributor nearest you.

For the name of your local Cummins-only distributor, or if you need more assistance, please call Onan Corporation, 1-612-574-5000, 7:30 AM to 4:30 PM, Central Standard Time, Monday through Friday.

When contacting your distributor, always supply the complete Model Number and Serial Number as shown on the generator set nameplate.

WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND MECHANICAL SERVICE.

Section 2. Specifications

GENERATOR DETAILS

Type Onan YD Revolving Field, 4-Pole, Brushless
Phase 1 and 3

3 Phase Ratings (For 1 phase rating, kW = kVA at 1.0 PF)

60 Hertz Continuous Standby

DGAB..... 20.0 kW (25.0 kVA at 0.8 PF)
DGAC 25.0 kW (31.25 kVA at 0.8 PF)
DGAD 30.0 kW (37.5 kVA at 0.8 PF)
DGAE..... 40.0 kW (50.0 kVA at 0.8 PF)

50 Hertz Continuous Standby

DGAB..... 16.0 kW (20.0 kVA at 0.8 PF)
DGAD 20.0 kW (25.0 kVA at 0.8 PF)
DGAE..... 32.0 kW (40.0 kVA at 0.8 PF)

ENGINE DETAILS

Engine

DGAB..... 4A2.3
DGAC, DGAD..... 6A3.4
DGAE..... 6AT3.4

Engine Speed

60 Hertz..... 1800 r/min
50 Hertz..... 1500 r/min

Fuel 2-D Diesel

Starting System Voltage..... 12

DGAB Battery Requirements

BCI Group Size 31
Reserve Capacity 95
Cold Cranking Amperes At 0°F (-18°C)..... 530
Battery Voltage 12
Quantity Required..... 1

DGAC, DGAD, DGAE Battery Requirements

BCI Group Size 31
Reserve Capacity 130
Cold Cranking Amperes At 0°F (-18°C)..... 625
Battery Voltage 12
Quantity Required..... 1

Cooling System Capacity (Engine and Radiator)

DGAB..... 12.2 QT (11.5 L)
DGAC, DGAD..... 17.8 QT (16.8 L)
DGAE..... 18.5 QT (17.5 L)

Engine Oil Capacity

DGAB..... 6 QT (5.7 L)
DGAC, DGAD..... 9 QT (8.5 L)
DGAE..... 12 QT (11.4 L)

Section 3. Operation

GENERAL

This section covers prestart checks, starting and stopping and operating the generator set. It is recommended each operator should read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set for safe operation.

PRESTART CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. Refer to the *MAINTENANCE* section for the recommended procedures.

Lubrication

Check the engine oil level. Keep the oil level near as possible to the dipstick high mark without overfilling.

Coolant

Check the engine coolant level. The coolant should be about two inches below the radiator cap opening. Do not check while the engine is hot.

⚠WARNING

Contact with hot coolant can result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.

Fuel

Make sure the fuel tanks have sufficient fuel and fuel system is primed. See the *MAINTENANCE* section for recommended fuel.

CONTROL PANEL

The following describes the function and operation of the standard Detector 7 and optional Detector 12 generator set control. All instruments and control switches are located on the face of the control panel as illustrated in Figure 3-1. The control panel is separated into a DC panel for monitoring the engine and an AC panel for monitoring the generator.

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- Dizziness
- Nausea
- Headache
- Weakness and Sleepiness
- Throbbing in Temples
- Muscular Twitching
- Vomiting
- Inability to Think Coherently

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

1-P/EM

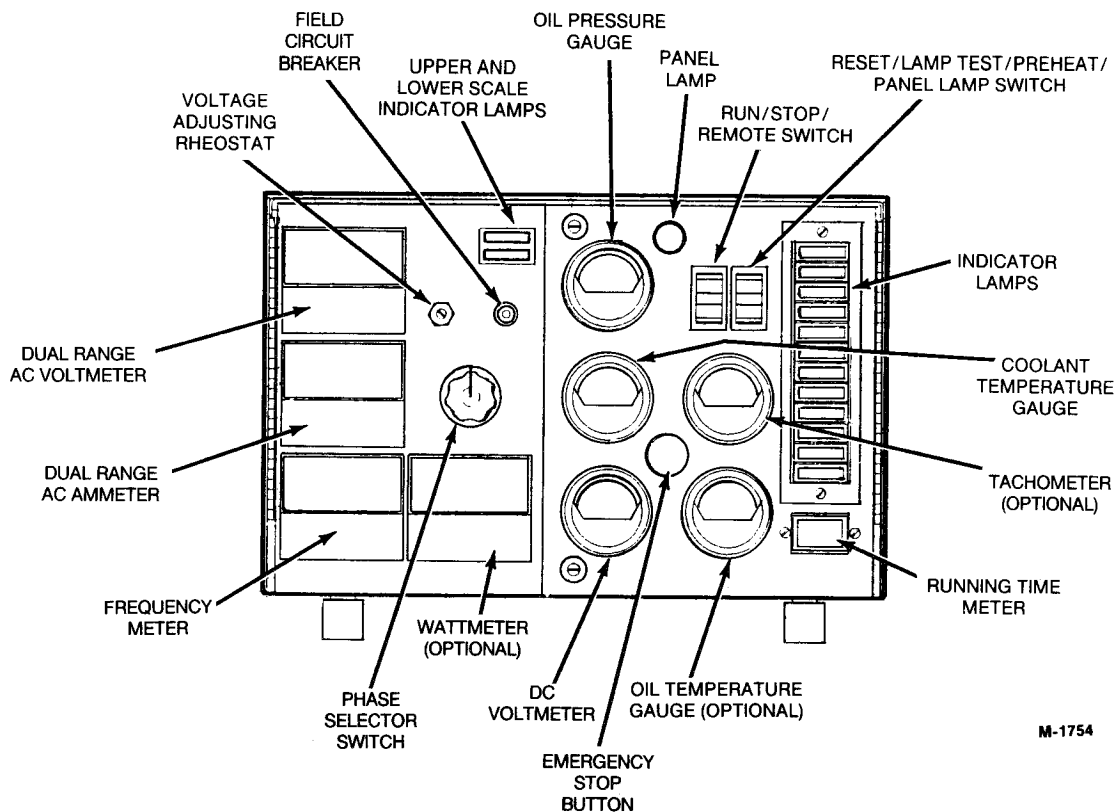


FIGURE 3-1. DETECTOR 12 CONTROL PANEL

DC Panel

Panel Lamp: Illuminates control panel.

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

Coolant Temperature Gauge: Indicates temperature of circulating coolant in engine (wired to a sensor unit located on the engine).

DC Voltmeter: Indicates the battery charging system voltage.

Run/Stop/Remote Switch: Starts and stops the unit locally, or from a remote location wired to the control engine monitor board.

Running Time Meter: Registers the total number of hours the unit has run. Use it to keep a record of periodic servicing. Time is cumulative; meter cannot be reset.

Reset/Lamp Test/Preheat/Panel Lamp Switch: Resets the fault circuit only when the Run/Stop/Remote switch is in the Stop (Reset) position. Tests fault lamps and turns on the control panel lamp. Also manually operates the engine Preheat.

Tachometer (Optional): Provides constant monitoring of engine r/min.

Oil Temperature Gauge (Optional): Indicates temperature of lubricating oil in engine (wired to a sensor unit located on the engine).

Emergency Stop Button (Optional): Push-in switch for emergency shutdown of the genset.

Detector 7-Indicator Lamps: The standard control panel has seven indicator lamps which are described as follows:

- RUN (green) lamp comes on when both starter circuits are opened after unit starting.
- PRE LO OIL PRES (yellow) indicates engine oil pressure is marginally low.
- PRE HI ENG TEMP (yellow) indicates engine temperature is marginally high.
- LO PRES (red) indicates engine has shut down because of critically low oil pressure.
- HI ENG TEMP (red) indicates engine has shut down because of critically high temperature.
- OVERSPEED (red) indicates engine has shut down because of excessive speed.
- OVERCRANK (red) indicates the starter has been locked out because of excessive cranking time.

Detector 12-Indicator Lamps: The optional twelve-lamp control version included all features of the seven-lamp version plus the following:

- **FAULT 1 (red)** an undedicated fault. May be factory programmed as a shutdown or non-shutdown, and as a timed or non-timed fault. (Normally set for timed shutdown).
- **FAULT 2 (red)** Same features as Fault 1 (Normally set for non-timed shutdown).
- **LOW ENG TEMP (yellow)** engine temperature is marginally low for starting. Indicates inoperative coolant heater.
- **LO FUEL (yellow)** indicates fuel supply is marginally low.
- **SWITCH OFF (flashing red)** indicates generator set is not in automatic start operation mode.

CAUTION Yellow lamps indicate potential problems that could damage the genset. Refer to Troubleshooting, Table 4-1.

AC Panel

AC Voltmeter (Optional): Dual range instrument indicating AC voltage. Measurement range in use shown on indicator light.

AC Ammeter (Optional): Dual range instrument indicates AC generator line current.

Wattmeter (Optional): Continuously gives reading of the generator output in kilowatts.

Frequency Meter (Optional): Indicates generator output frequency in hertz. It can be used to check engine speed (each hertz equals 30 r/min).

Voltage Adjusting Rheostat (Optional): Rheostat providing approximately plus or minus five percent adjustment of the rated output voltage.

Upper and Lower Scale Indicator Lamps (Optional): Indicates which scale to use on the AC voltmeter and ammeter.

Phase Selector Switch (Optional): Selects phases of generator output to be measured by AC voltmeter and AC ammeter.

Field Breaker: Provides generator exciter and regulator protection from overheating in the event of certain failure modes of generator, exciter and voltage regulator.

CONTROL PANEL INTERIOR

Generator AC Voltage Regulator

The solid-state regulator (VRAS-2) controls AC output voltage from the generator at a predetermined level regardless of load. Voltage regulation is plus or minus two percent from no load to full load. Random voltage variation is plus or minus one percent for constant loads.

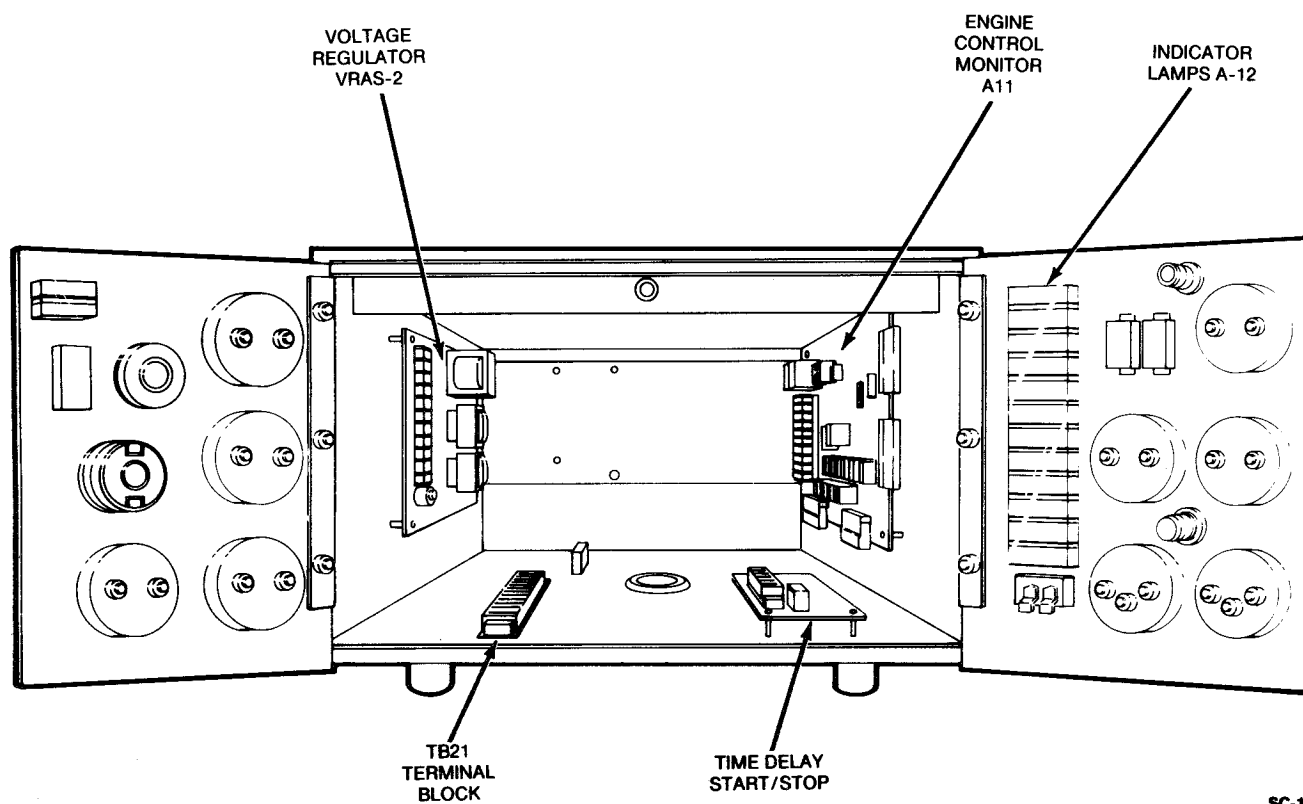
Engine Control Module

Electronic and relay components of the engine monitoring circuit are on a circuit board assembly. Sensor inputs (Figure 3-2) are connected by the wiring harness to plug connectors on the board. The control module protects the genset as follows:

- **Overcrank** - Limits engine cranking to 75 seconds. If engine fails to start, the module lights a fault lamp and opens the cranking circuit. The cycle cranking option allows three 15-second cranking cycles with two 15-second rest periods on the 12-lamp control.
- **Overspeed** - Shuts down the engine immediately if overspeed occurs and lights a fault lamp. The sensor switch is mounted in the end bell on the generator shaft. It is factory adjusted to shut down 60 hertz units at 2100 ± 90 r/min, 50 hertz units at 1850 ± 50 r/min.
- **Low Oil Pressure** - Shuts down the engine immediately if oil pressure drops below 14 psi (97 kPa) and lights a fault lamp. The fault is time-delayed about 10 seconds following starter disconnect and inhibited during cranking. The delay allows oil pressure to rise to normal before the electronic control module monitors this system.
- **High Engine Temperature** - shuts down the engine immediately if coolant temperature rises above 222°F (106°C) and lights a fault lamp. The fault is time-delayed about 10 seconds following starter disconnect and inhibited during cranking. This delay allows coolant in a hot engine time to circulate and return the water jacket to normal before the electronic control module monitors this system.

A pre-low oil pressure sensor and lamp provides an alarm that oil pressure is marginally low, 20 psi (137 kPa) or less. The cause should be found and corrected as soon as possible.

A pre-high engine temperature sensor and lamp provides an alarm that engine temperature is marginally high, 202°F (94°C). The cause should be found and corrected as soon as possible.



SC-1617-1

FIGURE 3-2. CONTROL PANEL INTERIOR

Detector 12-Indicator Lamps: The optional twelve-lamp control version included all features of the seven-lamp version plus the following:

- **FAULT 1 (red)** an undedicated fault. May be factory programmed as a shutdown or non-shutdown, and as a timed or non-timed fault. (Normally set for timed shutdown).
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A pre-low oil pressure sensor and lamp provides an alarm that oil pressure is marginally low, 20 psi (137 kPa) or less. The cause should be found and corrected as soon as possible.

A pre-high engine temperature sensor and lamp provides an alarm that engine temperature is marginally high, 202°F (94°C). The cause should be found and corrected as soon as possible.

⚠ CAUTION

The high engine temperature shutdown system will not operate if the coolant level is too low. The high engine temperature sensor monitors coolant temperature. Loss of coolant will prevent sensor operation and allow the engine to overheat causing severe damage to the engine. Therefore, maintain adequate coolant level for proper operation of the high engine temperature shutdown system.

- Low Coolant Level Shutdown (Optional) - A solid state switch provides engine shutdown if coolant level falls too low. It also turns on the high engine temperature fault lamp.

STARTING

The following sections cover the three systems used to start the generator set. Review *Prestart Preparation* in Installation Manual.

Starting at Control Panel

Press Preheat switch for 10 seconds maximum before starting. Move the Run-Stop-Remote switch on the DC panel (Figure 3-1) to the RUN position. This will activate the engine control system and the starting system. The starter will begin cranking and after a few seconds the engine should start. The starter will disconnect when the engine reaches a speed of 450 to 570 r/min.

If the engine does not start, the starter will disengage after a specified period of time and the control will indicate an overcrank fault. Generator sets with the standard overcrank control will crank continuously for up to 75 seconds before disengaging the starter. Generator sets with the cycle cranking option will crank for 15 seconds and then stop for 15 seconds until 3 cycles have been completed. To clear an overcrank fault, place the Run-Stop-Remote switch in the STOP position and momentarily depress the Reset switch. Wait two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt at starting, refer to the Troubleshooting section.

Starting From Remote Location

Move the Run/Stop/Remote switch on the generator set DC panel to the REMOTE position. This allows the generator set to be started from a remote switch. Closing the remote switch initiates the starting sequence described in the previous section.

Automatic Starting

Place the Run/Stop/Remote switch on the generator set DC panel in the REMOTE position if an automatic transfer switch is used. This allows the transfer switch to start the generator set if a power outage occurs and stop it when the power returns.

STOPPING

Before Stopping

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

To Stop

If the set was started at the set control panel or at a remote control panel, move the Run/Stop/Remote switch or remote starting switch to the STOP position. If the set was started by an automatic transfer switch, the set will automatically stop about 15 minutes after the normal power source returns.

BREAK-IN

Drain and replace the crankcase oil after the first 50 hours of operation on new generator sets. Refer to the MAINTENANCE section of this manual for the recommended procedures.

NO-LOAD OPERATION

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of heater element, etc.

EXERCISE PERIOD

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting. Exercise the generator set at least once a week for a minimum of 30 minutes with load so the engine reaches normal operating temperatures.

Onan automatic transfer switches have as an option an exerciser that can be preset to provide regular exercise periods. Typically the exerciser can be set for time of start, length of run, and day of week.

Section 4. Troubleshooting

The generator set has a number of sensor units that continuously monitor the engine for abnormal conditions such as low oil pressure or high coolant temperature. If an abnormal condition does occur, the engine monitor will activate a fault lamp and may also stop the engine depending on the condition. If the generator set does shut down, the operator may be able to restart the set after making certain adjustments or corrections. This section describes the operation of the fault condition system and suggested troubleshooting (Table 4-1) procedures for the operator.

The standard seven light control has a single green light to indicate RUN, two amber pre-fault lights and four red fault lights. The optional twelve light control has a single green light to indicate RUN, four amber lights and seven red fault lights. Both controls also have a terminal connection for an audible alarm which will sound when a fault occurs.

Safety Considerations

High voltages are present within the control box and generator output box when the generator is running. Do not open the control box or generator output box while set is running.

⚠ WARNING *Contacting high voltage components can cause serious personal injury or death. Keep control and output box covers in place during troubleshooting.*

Generator set installations are normally designed for automatic starting or remote starting. When troubleshooting a set that is shut down, make certain the

generator set cannot be accidentally restarted. Place the Run/Stop/Remote switch in the STOP position and remove the negative battery cable from the set starting battery.

⚠ WARNING *Accidental starting of the generator set during troubleshooting can cause severe personal injury or death. Disable the generator set before troubleshooting.*

When a fault comes on during operation, follow the procedures in Table 4-1 to locate and correct the problem. For any symptom not listed, contact an Onan Distributor for service.

Resetting the Control

The external alarm and fault lamp can be deactivated by placing the Run/Stop/Remote switch in the Stop position and pressing the Reset/Lamp Test/Preheat switch. Locate the problem and make the necessary corrections before restarting the generator set. While pressing the Reset/Lamp Test/Preheat switch, observe that all lamps light.

Line Circuit Breaker (Optional)

The optional line circuit breaker mounts on the generator output box. If the load exceeds the generator current rating, the line circuit breaker will open to prevent the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as required. Manually reset the breaker to reconnect the load to the generator.

TABLE 4-1. TROUBLESHOOTING

WARNING Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.

SYMPTOM	CORRECTIVE ACTION
1. Green RUN lamp lights following engine start-up.	1. Indicates all engine systems are normal. No corrective action required.
2. PRE HI ENGINE TEMP lamp lights. Engine continues to operate.	2. Indicates engine has begun to overheat and engine temperature has risen to approximately 202°F (94°C). If generator is powering non-critical and critical loads and cannot be shutdown, use the following: <ol style="list-style-type: none"> Reduce load if possible by turning off non-critical loads. Check air inlets and outlets and remove any obstructions to airflow. Open doors or windows in generator area to increase ventilation. If engine can be stopped, follow procedure in step 3.
3. HI ENG TEMP lamp lights. Engine shuts down.	3. Indicates engine has overheated (engine temperature has risen above 222°F/106°C) or coolant level is low (sets with coolant level sensor). Allow engine to cool down completely before proceeding with the following checks: <ol style="list-style-type: none"> Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary. Check for obstructions to cooling airflow and correct as necessary. Check for a slipping fan belt and tighten if loose. Reset control and restart after locating and correcting problem. Contact an authorized dealer or distributor if none of the above.
4. PRE LO OIL PRES lamp lights. Engine continues to operate.	4. Indicates engine oil pressure has dropped to 20 psi (138 kPa). If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow step 5 procedure. If engine can be stopped, follow procedures in step 5.
5. LO OIL PRES lamp lights. Engine shuts down NOTE: See also step 6.	5. Indicates engine oil pressure has dropped to 14 psi (97 kPa). Check oil level, lines and filters. If oil system is okay but oil level is low, replenish. Reset control and restart. Contact an authorized dealer or distributor if oil pressure is not in the range of 30 to 55 psi (206 to 379 kPa).

TABLE 4-1. TROUBLESHOOTING (Continued)



WARNING Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.

SYMPTOM	CORRECTIVE ACTION
<p>6. OVERCRANK lamp lights and engine stops cranking.</p> <p>or</p> <p>Engine runs, shuts down, and LO OIL PRES lamp lights.</p>	<p>6. Indicates possible fuel system problem.</p> <ol style="list-style-type: none"> Check for empty fuel tank, fuel leaks, or plugged fuel lines and correct as required. Check for dirty fuel filter and replace if necessary (see MAINTENANCE section). Check for dirty or plugged air filter and replace if necessary (see MAINTENANCE section). Refer to Step 5. Reset the control and restart after correcting the problem. Contact an authorized dealer or distributor for service if none of the above.
<p>7. Engine runs and then shuts down, OVERSPEED lamp lights.</p>	<p>7. Indicates engine has exceeded normal operating speed. Contact an authorized dealer or distributor for service.</p>
<p>*8. SWITCH OFF lamp flashes.</p>	<p>8. Indicates Run/Stop/Remote switch is in the Stop position which will prevent automatic starting if an automatic transfer switch is used. Move the Run/Stop/Remote switch to the Remote position for automatic starting.</p>
<p>*9. LO FUEL lamp lights. Engine continues to run.</p>	<p>9. Indicates diesel fuel supply is running low. Check fuel supply and replenish as required.</p>
<p>*10. LO FUEL lamp lights. Engine shuts down and LO OIL PRES lamp lights.</p>	<p>10. Indicates engine has run out of fuel. Check fuel level and replenish as required.</p>
<p>*11. LO ENG TEMP lamp lights. Set is in standby mode but is not operating.</p> <p>(Lamp lights when engine coolant temperature is 70°F (21°C) or lower. Since the lamp goes out after the engine warms up, there should be no cause for alarm even during initial generator set operation.)</p>	<p>11. Indicates engine coolant heater is not operating or is not circulating coolant. Check for the following conditions:</p> <ol style="list-style-type: none"> Coolant heater not connected to power supply. Check for blown fuse or disconnected heater cord and correct as required. Check for low coolant level and replenish if required. Look for possible coolant leakage points and repair as required. Contact an authorized dealer or distributor if none of the above.

*12-Light Panel Only.

TABLE 4-1. TROUBLESHOOTING (Continued)

WARNING Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.

SYMPTOM	CORRECTIVE ACTION
12. The FAULT 1 or FAULT 2 fault lamp lights. Engine shuts down immediately, engine runs for several seconds and then shuts down, or engine continues to run.	12. The standard undesignated fault functions are programmed to shut down the set when a fault is sensed. Fault 1 is time delayed while Fault 2 is immediate. The nature of the fault is an optional selection that is determined when the set installation is designed. The undesignated fault functions may also be programmed for non-shutdown or non-time delay.
13. Fault lamp lights but no fault exists. Engine gauges show oil pressure, engine temperature, and frequency (speed) are within normal limits.	13. The monitor board or a sensor may be at fault. Contact an authorized dealer or distributor for service.
14. Engine starts from generator control panel, but will not start automatically or from a remote panel. (Note: The Run/Stop/Remote switch must be in the Remote position for automatic or remote starting).	14. Remote circuit breaker is tripped, Reset breaker and restart. Contact an authorized dealer or distributor if breaker trips after resetting.
15. Engine will not crank.	15. Indicates possible fault with control or starting system. Check for the following conditions: a. Fault lamp on. Correct fault and reset control. b. Poor battery cable connections. Clean the battery cable terminals and tighten all connections. c. Discharged or defective battery. Recharge or replace the battery. d. Contact an authorized dealer or distributor for assistance if none of the above.
16. No AC output voltage.	16. Field breaker is tripped. Reset breaker. Contact an authorized dealer or distributor if voltage build up causes breaker to trip.
17. Green RUN lamp does not light following engine start-up.	17. Indicates possible Start/Disconnect relay failure. Contact an authorized dealer or distributor for assistance.

* - 12-Light Panel Only.

Section 5. Maintenance

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. The table below covers the recommended service intervals for a generator set on STANDBY service. If the set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with an authorized dealer or distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use Table 5-1 to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

⚠ WARNING *Accidental starting of the set can cause severe personal injury or death. Disconnect the battery cables (ground cable first) when repairs are made to the engine, controls, or generator.*

TABLE 5-1. MAINTENANCE SCHEDULE

MAINTENANCE CHECKS	SERVICE TIME				
	Daily or after 8 hours	Weekly or after 50 hours	Monthly or after 100 hours	6 Months or after 200 hours	12 Months or after 400 hours
Inspect Generator Set	x ¹				
Check Oil Level	x				
Check Fan Belt	x				
Check Coolant Level	x				
Check Coolant Heater (if equipped)	x				
Check Air Cleaner		x ²			
Check Battery Charging System		x			
Drain Water and Sediment from Fuel Tanks		x ⁶			
Exercise Standby Sets		See Note 8			
Check Anti-freeze Concentration			x		
Drain Exhaust Condensate Trap			x		
Check Fuel Level			x		
Change Crankcase Oil and Filter (Turbo)		See Note 3	x ^{2,3}		
Change Crankcase Oil and Filter (Non-Turbo)		See Note 3		x ^{2,3,4}	
Check Battery Condition				x	
Change Air Cleaner Element (Standard)				x	
Clean Generator Assembly				x	
Change Air Cleaner Element (Heavy Duty)					x
Clean Crankcase Breather Cap (Turbo)					x
Change Fuel Filter					x ^{2,5}
Check Valve Lash Clearance		See Note 3			x ^{3,7}

¹ - Check for oil, fuel, cooling, and exhaust system leaks. Check exhaust system audibly and visually with set running. Shut unit down and repair any leaks immediately.

² - Perform more often in extremely dusty conditions.

³ - Perform after first 50 hours of operation on new sets.

⁴ - Perform every 200 hours or 6 months, whichever comes first.

⁵ - Perform every 400 hours or 12 months, whichever comes first.

⁶ - Drain 1 cup or more of fuel to remove water and sediment.

⁷ - Contact an authorized service center for service.

⁸ - Exercise standby sets weekly. Refer to Operation section.

GENERATOR SET INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected to provide continued safe operation.

Engine Gauges

Check the following while the generator set is operating.

Oil Pressure Gauge: The oil pressure should be in the range of 30 to 55 psi (207 to 380 kPa) when the engine is at operating temperature.

Water Temperature Gauge: The water temperature should be in the range of 165° to 195°F (74° to 91°) depending on the load and ambient temperature.

Battery Charge Rate DC Voltmeter: Indicates the battery charging system voltage.

AC Meters (If Equipped)

Check the following while the generator set is operating.

Frequency Meter: The generator frequency should be stable and the reading should be the same as the nameplate rating (50 or 60 Hertz).

AC Voltmeter: Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2 on single phase sets; L1-L2, L2-L3, and L3-L1 on three phase sets). Read the AC voltmeter using the upper or lower scale as indicated by the scale indicator light.

AC Ammeter: Turn the phase selector switch to each phase selection shown on the Amps scale (L1 and L2 on single phase sets; L1, L2, and L3 on three phase sets). Read the ammeter using the upper or lower scale as indicated by the scale indicator light. At no load, the current readings should be zero. With a load applied, each line current should be about the same and no line current should exceed the set nameplate rating.

Engine Monitor Indicator Lights

Hold the Reset/Lamp Test/Preheat switch in the Test position. All indicator lamps (except Run) should light. Verify that all of the bulbs are on and then release the switch. Replace any bulbs that are burned out.

Exhaust System

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, have them corrected immediately.

WARNING

Inhalation of exhaust gases can result in serious personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair any leaks immediately.

Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage.

WARNING

Leaking fuel will create a fire hazard which can result in severe personal injury or death if ignited by a spark. If any leaks are detected, have them corrected immediately.

DC Electrical System

With the generator set off, check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always connect the negative battery cable last to reduce the possibility of arcing.

WARNING

Ignition of explosive battery gases can cause severe personal injury. Do not smoke while servicing batteries.

Mechanical

With the generator set stopped, check for loose belts, and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately. With the set running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate anything that indicates possible mechanical problems.

LUBRICATION SYSTEM

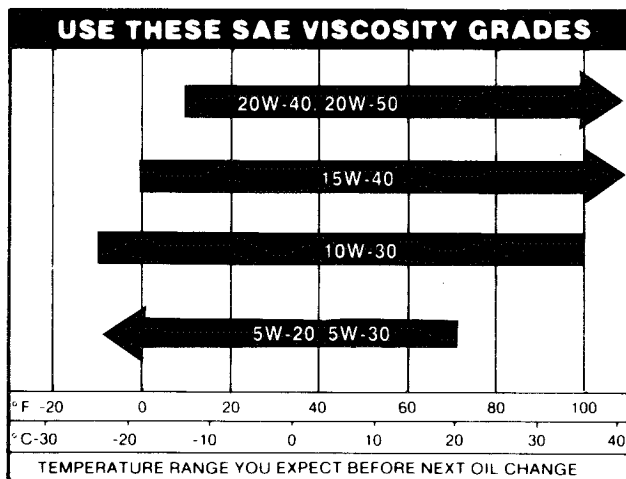
The engine oil was drained from the crankcase prior to shipment. Before the initial start, the lubrication system must be filled with oil of the recommended classification and viscosity. Refer to the *Specifications* section for the lubricating oil capacity.

Use multigrade lubricating oils with the American Petroleum Institute (API) classification CD/SF or CE/SF. Table 5-2 shows preferred oil grades for ambient temperatures indicated.

When selecting the oil viscosity, pick the grade that is right for the **LOWEST** temperature expected. Oil that is too thick can result in a lack of lubrication when engine is started.

Single grade oils can be substituted for short durations until the recommended multigrade oil is procured.

USE THESE SAE VISCOSITY GRADES



LS-1177

Check the engine oil level during engine shut-down periods at the intervals specified in the Maintenance Table. The oil dipstick and oil fill are located on the side of the engine (see Figure 5-1). The dipstick is stamped with FULL and ADD to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

Keep the oil level as near as possible to the FULL mark on the dipstick. Remove the oil fill cap and add oil of the same quality and brand when necessary.

▲CAUTION *Do not operate the engine with the oil level below the ADD mark or above the FULL mark. Overfilling can cause foaming or aeration of the oil while operation below the ADD mark can cause loss of oil pressure.*

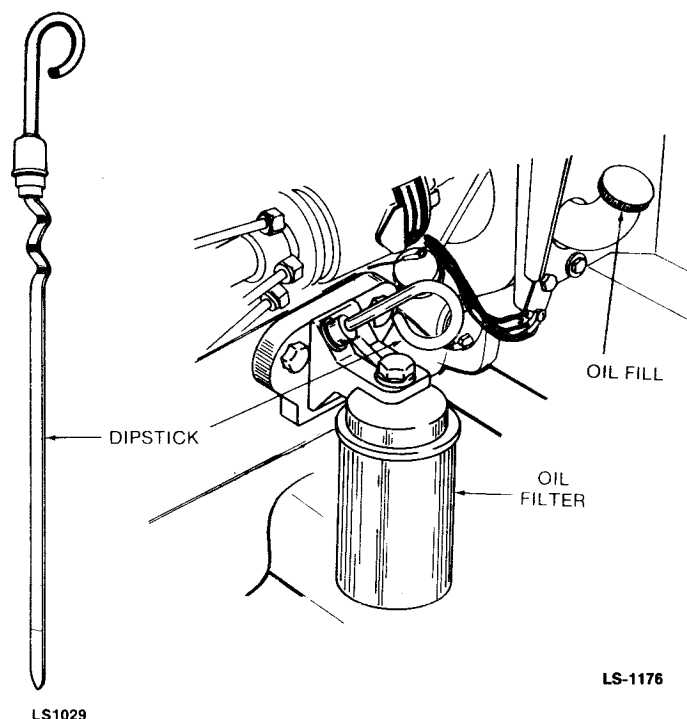


FIGURE 5-1. ENGINE OIL

Change the oil and filter at the intervals recommended in the maintenance table. Use oil that meets the API classification and viscosity requirements as indicated in the previous section.

Engine Oil Change: Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API classification and appropriate SAE viscosity grade for the temperature conditions.

▲WARNING *Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.*

Oil Filter Change: Spin off oil filter and discard it. Thoroughly clean filter mounting surface. Apply a thin film of oil to filter gasket and install new element. Spin element on by hand until gasket just touches mounting pad and then turn an additional 1/4 to 1/2 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks, but do not overtighten.

COOLING SYSTEM

The cooling system on each set is drained prior to shipping and must be refilled before being operated. The cooling system capacity of the standard unit with set mounted radiator is shown in the *Specifications* section.

Coolant Requirements

A satisfactory engine coolant inhibits corrosion and protects against freezing. A solution of ethylene glycol anti-freeze (permanent type) and water is recommended for normal operation and storage periods. Choose only a reliable brand of anti-freeze that contains a rust and corrosion inhibitor but does not contain a stop-leak additive.

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Use soft water whenever available. Well water often contains lime and other minerals which eventually may clog the radiator core and reduce the cooling efficiency.

Be sure the anti-freeze solution will protect the cooling system during the coldest winter weather. However, use a 50/50 mixture of anti-freeze and clean water to provide adequate corrosion protection.

Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps secure. Remove the cooling system pressure cap and slowly fill the cooling system with the recommended coolant. Limit the fill rate to 3 gallons/minute to allow the engine block to fill completely with coolant.

▲CAUTION *Exceeding the recommended fill rate can cause incomplete filling of the engine block which can result in possible engine damage during warm-up. Always follow the recommended fill procedure.*

When the engine is first started, remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable.

Coolant Level

Check the coolant level during shutdown periods at the intervals specified in the *Maintenance* Table. Remove the radiator cap after allowing the engine to cool and if necessary, add coolant until the level is near the top of the radiator.

▲WARNING *Remove the radiator pressure cap slowly after the engine has cooled. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury from the hot coolant.*

▲CAUTION *High Engine Temperature Cutoff will shut down engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device, thereby causing severe damage to the engine. It is therefore imperative that adequate engine coolant levels be maintained, to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.*

Flushing and Cleaning

For efficient operation, the cooling system should be drained, flushed, and refilled once a year.

To drain the system completely, the radiator drain and the cylinder block drain located on the right side of engine must be opened.

Chemical Cleaning: Thoroughly clean the cooling system if rust and scale have collected on the engine water jacket or in the radiator. Rust and scale slow down heat absorption and can block the coolant flow. Use a good radiator cleaning compound in accordance with instructions furnished by the supplier.

Flushing: After cleaning or before filling the system with new coolant, drain the block and radiator and fill with clean water. Operate the set for 10 minutes and then drain the system completely. Refill with the recommended coolant.

▲CAUTION *Never pour hot water into a cold engine or cold water into a hot engine. Doing so can crack the head or the cylinder block. Do not operate the unit without water for even a few minutes.*

FUEL SYSTEM

Use only a good quality fuel obtained from a reputable supplier. The quality of fuel used is important in obtaining dependable performance and satisfactory engine life. Fuels must be clean, completely distilled, well refined, and non-corrosive to fuel system parts.

▲WARNING *Ignition of fuel can cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, spark, pilot light, arcing equipment or other igniter near the fuel system.*

Fuel Recommendations

Use ASTM 2-D (No. 2 Diesel) or ASTM 1-D (No. 1 Diesel) fuel with a minimum Centane number of 45*. Number 2 diesel fuel gives the best economy and performance under most operating conditions. Use number 1 diesel fuel when ambient temperatures are below 0°C (32°F) and during long periods of light engine load.

***NOTE:** Fuels with Cetane numbers higher than 45 may be needed in higher altitudes or when extremely low ambient temperatures are encountered to prevent misfires and resultant excessive smoke.

Use low sulfur content fuel having a cloud point of at least 10 degrees below the lowest expected fuel temperature. Cloud point is the temperature at which wax crystals begin to form in diesel fuel.

Fuel Handling Precautions

Take appropriate precautions to prevent the entrance of dirt, water or other contaminants into the fuel system. Filter or strain the fuel as the tank is filled.

⚠CAUTION

Due to the precise tolerances of diesel injection systems, dirt or water in the fuel can cause severe damage to both the injection pump and injector nozzles. Take special precautions to keep the fuel clean and free of water.

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the daytime. At night, cool air tends to lower the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and tend to form condensation.

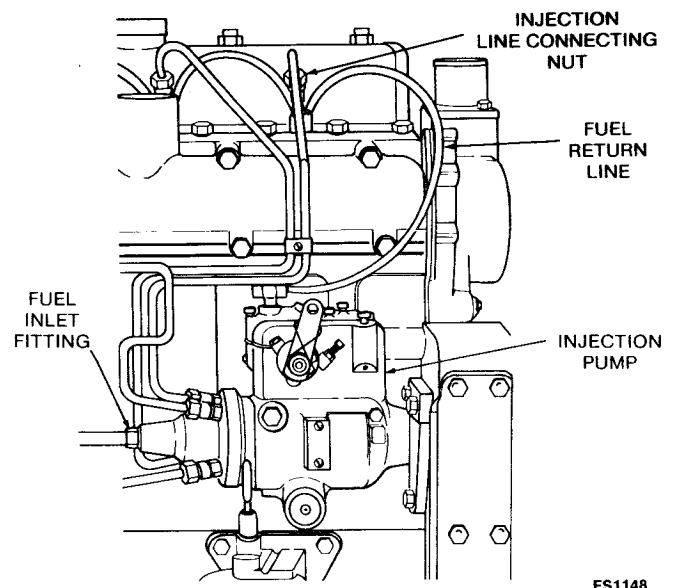
Condensation (water) can cause clogging of fuel filters as well as freezing problems. In addition, water mixing with the sulphur in the fuel forms acid which can corrode and damage engine parts.

Priming the Fuel System

The fuel system must be primed prior to initial start up or after engine has run out of fuel.

Low Pressure Fuel System: The transfer pump, fuel filter and injection pump housing comprise the low pressure fuel system. Use the following procedure to remove the trapped air from the system.

1. Check fuel level in fuel tank and open shut off valve.
2. Loosen the fuel filter to injection pump line at the injection pump fuel inlet fitting (Figure 5-2).



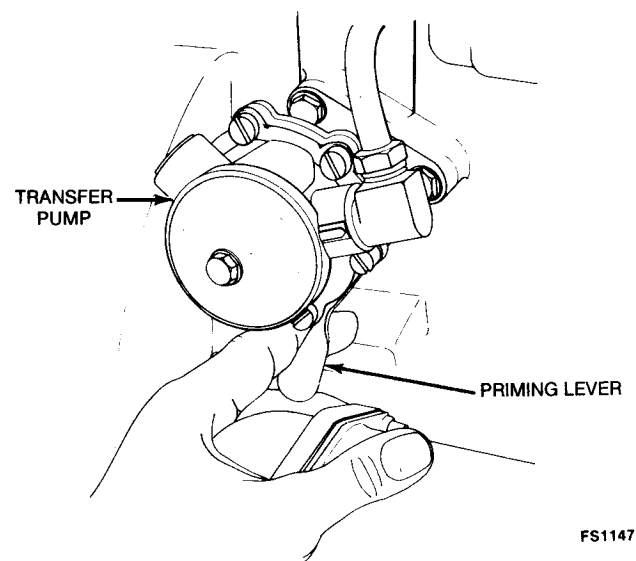
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FIGURE 5-2. INJECTION PUMP

3. Actuate the priming lever (Figure 5-3) on the side of the transfer pump until fuel flows from the fitting.

If the camshaft transfer pump lobe is up, turn engine one revolution to permit hand priming.

4. Tighten fuel line at the injection pump inlet.



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FIGURE 5-3. FUEL TRANSFER PUMP

High Pressure Fuel System: The injection pump, fuel injection lines and fuel injectors comprise the high pressure fuel system. This part of the system is usually self-priming since any trapped air is usually forced out through the injection nozzles. However, if the engine has run out of fuel, been shut down for an extended period of time or has had the injection lines removed, it may be necessary to prime. Use the following procedures:

1. Loosen fuel injection line connecting nut (Figure 5-2) attaching each line to corresponding nozzle holder.
2. Energize the starting motor by placing the Run/Stop/Remote switch in the Run position.
3. After 30 seconds, place the Run/Stop/Remote switch in the Stop position and pause for two minutes to permit the starter motor to cool.
4. Discontinue priming when fuel flows from the end of all high pressure fuel injection lines. Tighten connection nuts and torque to 18 ft-lbs (24 N•m).

⚠WARNING *Keep hands away from spray. The discharge pressure can penetrate the skin and can cause blood poisoning or a serious skin infection.*

Fuel Filter

The combination primary and secondary fuel filter is a disposable type. Any dirt that passes through the primary section is trapped by the secondary section. This prevents dirt from entering fuel injection pump.

The filter replacement interval will vary according to the fuel quality and cleanliness. Using the wrong fuel or dirty fuel will shorten the service life of the filter.

Refer to the *Periodic Maintenance Schedule* for the recommended filter change interval. However, if the engine shows signs of fuel starvation (reduced power or surging), change the fuel filter. Use the following procedures to replace.

1. Close fuel tank shut off valve.
2. Clean all dirt from around filter, filter base and surrounding area.
3. Remove filter retaining clip or clips from fuel filter (see Figure 5-4).
4. Remove old filter and dispose of it properly.

⚠CAUTION *Due to the precise tolerances of diesel injection systems, dirt or water in the fuel can cause severe damage to both the injection pump and injector nozzles. Take special precautions to keep the fuel clean and free of water.*

5. Install new fuel filter and prime fuel system.

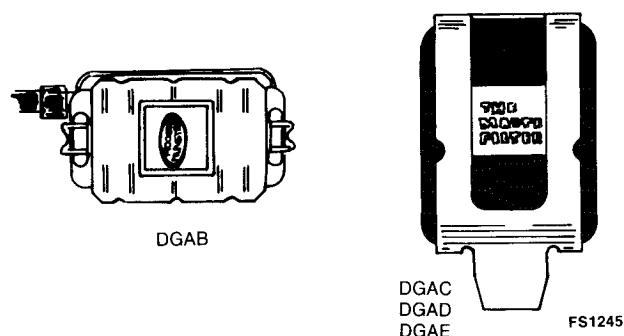


FIGURE 5-4. FUEL FILTERS

AIR CLEANER

Two types of air cleaners are available. Refer to the maintenance procedures that correspond to your generator set.

Standard Air Cleaner

The standard air cleaner uses a disposable type filter element (see Figure 5-5). Inspect and replace at the intervals recommended in the *Periodic Maintenance Schedule*. Replace more often than recommended if the set is operated in extremely dusty or dirty conditions.

In addition, inspect the air cleaner body periodically for dents and cracks. Check for damaged gaskets and hoses, loose hose clamps and leaks that would allow unfiltered air to enter the engine. Correct any such condition by the immediate repair or replacement of the faulty parts.

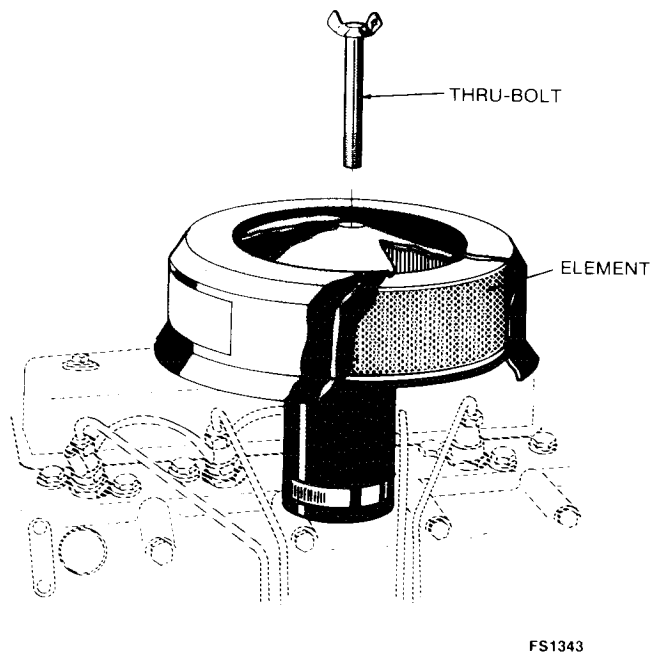


FIGURE 5-5. STANDARD AIR CLEANER

Heavy Duty Air Cleaner

A heavy duty air cleaner is standard on the DGAE, and optional on the other generator sets. It uses a heavy duty element that can be cleaned and reused if desired, or replaced. Use the following procedures to service:

1. Remove the dust cap (see Figure 5-6).
2. Clean dust and debris from the rubber dust collector in the dust cap.
3. Remove the wing nut and the air filter element.
4. Clean the element by directing dry, clean low pressure air up and down the pleats on the inside of the element. If the element is extremely dirty, it can be washed by soaking in a mild detergent and water. Soak for 15 minutes and then rinse thoroughly with clean water.
5. Air dry the element for a minimum of 24 hours. Do not dry with compressed air or at temperatures greater than 150°F (66°C).
6. Reassemble, making certain the dust cap "TOP" is facing up.

⚠ CAUTION

Do not reuse the element more than twice. Replace if element has even the slightest hole to prevent engine damage from dirt.

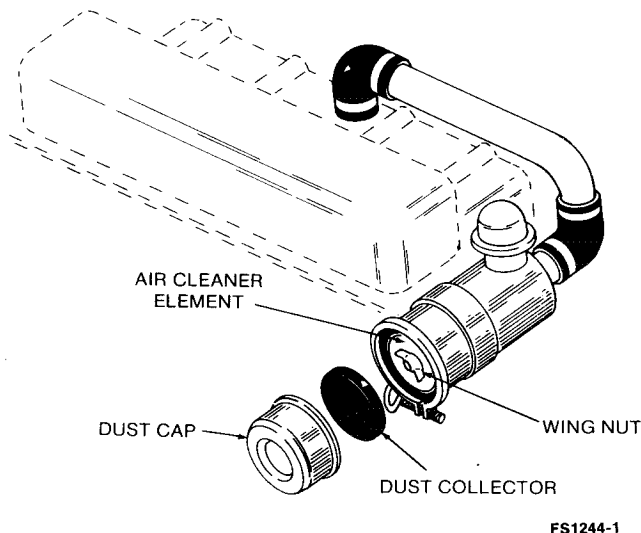


FIGURE 5-6. HEAVY DUTY AIR CLEANER

FAN BELT

To adjust, loosen alternator bolt that passes through elongated slot in mounting bracket. Slide alternator until a fan belt tension of 60 lbs. (267 N) is obtained. Tighten alternator mounting bolt to lock alternator in place. Check tension and repeat if necessary. See Figure 5-7.

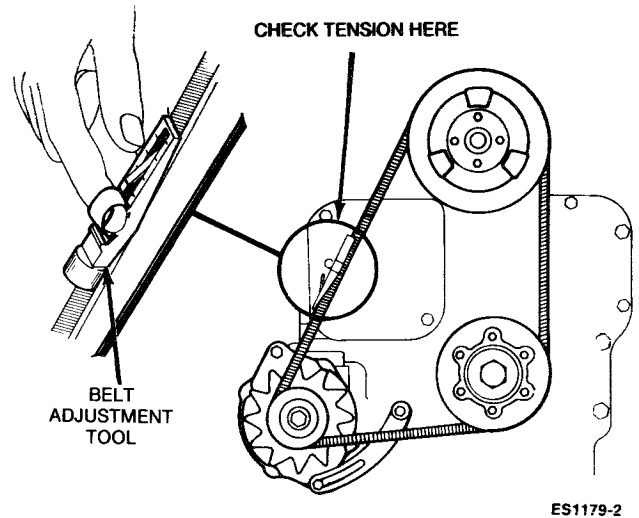


FIGURE 5-7. FAN BELT ADJUSTMENT

VALVE CLEARANCE

Correct valve clearance is very important in diesel engine performance because of the high compression developed in the cylinders. Incorrect valve clearance will cause loss of compression, misfiring, noise and may eventually lead to damaged engine components. Always perform valve clearance adjustments with the piston near top dead center on its compression stroke and intake and exhaust valves closed. For detailed valve clearance adjustment procedures, contact your authorized dealer or distributor service center.

BATTERY

Check the condition of the starting battery at the interval specified in the Periodic Maintenance Schedule. To prevent dangerous arcing, always disconnect the negative ground strap from the battery before working on any part of the electrical system or the engine. Disregard the sections on Checking Specific Gravity and Checking Electrolyte Level if using a maintenance free type battery.

⚠ WARNING

Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any source of ignition while servicing batteries.

Cleaning Batteries

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with an ammonia solution or a solution consisting of 1/4 pound of baking soda added to 1 quart of water.

Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery and surrounding areas with clean water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every five degrees the electrolyte temperature is above 80°F (27°C) or subtracting four gravity points for every five degrees below 80°F (27°C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

Checking Electrolyte Level

Check the level of the electrolyte (acid and water solution) in the batteries at least every 200 hours of operation.

Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

⚠CAUTION *Do not add water in freezing weather unless the engine will run long enough (two to three hours) to assure a thorough mixing of water and electrolyte.*

AC GENERATOR

There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections, to coincide with engine oil changes, will ensure good performance.

Remove the generator output box cover and inspect the rotating rectifier assembly to make sure the diodes (see Figure 5-8) are free of dust, dirt and grease. Excessive foreign matter on these diodes and heat sinks will cause the diodes to overheat and will result in their failure. Blow out the assembly periodically with filtered low pressure air.

⚠CAUTION *Excessive foreign matter on diodes and heat sinks will cause overheating and possible failure.*

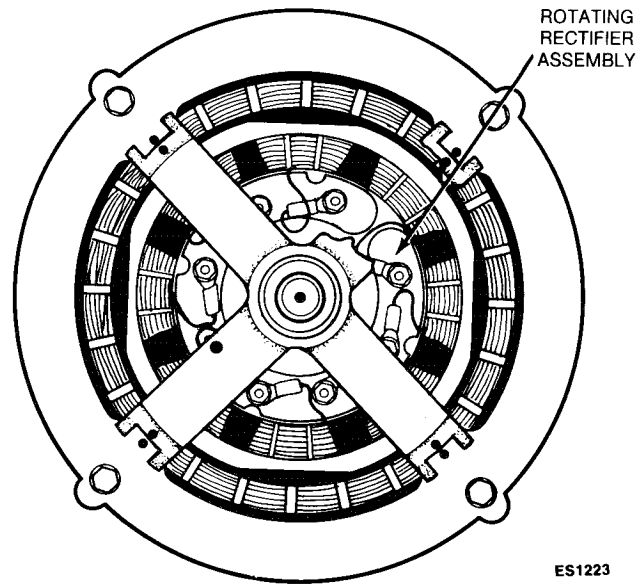


FIGURE 5-8. GENERATOR END VIEW

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours of running.

If unit is used for "Prime Power," replace the bearing every 10,000 hours or two years. If the unit is used for "Standby," replace the bearing every five years. Deterioration of the bearing grease due to oxidation makes this replacement necessary.

If generator requires major repair or servicing, contact an authorized Onan Distributor.

CRANKCASE VENTILATION (DGAE)

Crankcase ventilation on turbocharged engines is achieved through an external breather. This crankcase breather must be cleaned after every 400 hours of engine operation. Remove breather assembly, clean breather with cleaning solvent, allow to dry, and replace on engine.

⚠WARNING *Solvents can be poisonous, irritating to the skin and explosive. Follow manufacturer's safety precautions when using solvents.*

OUT-OF-SERVICE PROTECTION

The inherent lubricating qualities of No. 2 diesel fuel normally should protect the cylinders of a diesel engine for at least 30 days when the unit is not in service. To protect an engine that will be out of service for more than 30 days, proceed as follows:

1. Exercise the generator set as described in the *Operation* section until the engine is up to operating temperature.
2. Shut down engine and drain oil base while still warm. Refill and attach a warning tag indicating viscosity of oil used.
3. Service air cleaner.
4. Check the coolant level and add more coolant if the level is low.
5. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
6. Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of grease or oil.
7. Disconnect battery and store in a cool dry place. Connect battery to a charger every 30 days to maintain it at full charge.
8. Provide a suitable cover for the entire unit after unit has cooled down.

Returning a Unit to Service

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check warning tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Clean and check battery. Measure specific gravity (1.260 at 80°F [27°C]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. **DO NOT OVERCHARGE.**

WARNING

Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any ignition source while servicing batteries.

4. Drain and flush the cooling system and refill with the recommended coolant.
5. Prime the fuel system.
6. Connect starting battery (ground terminal last).
7. Remove all loads before starting the engine.
8. After start, apply load to at least 50 percent of rated capacity.
9. Check all gauges for normal readings. Set is ready for service.

